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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/711,015 | 08/18/2004 | Jei-Ming Chen | NAUP0596USA | 5014 |
| 27765 | 7590 | 11/16/2005 | EXAMINER | |
| NORTH AMERICA INTELLECTUAL PROPERTY CORPORATION P.O. BOX 506 MERRIFIELD, VA 22116 | | | | QUINTO, KEVIN V |
| ART UNIT | | PAPER NUMBER | | |
| | | 2826 | | |

DATE MAILED: 11/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

EZ

| | | |
|------------------------------|---------------------------------|-------------------------|
| Office Action Summary | Application No. | Applicant(s) |
| | 10/711,015 | CHEN ET AL. |
| | Examiner Kevin Quinto | Art Unit 2826 |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
 - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
 - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 07 September 2005.
- 2a) This action is FINAL. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 1-8 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 1-8 is/are rejected.
- 7) Claim(s) _____ is/are objected to.
- 8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) All b) Some * c) None of:
1. Certified copies of the priority documents have been received.
2. Certified copies of the priority documents have been received in Application No. _____.
3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed September 7, 2005 have been fully considered but they are not persuasive. The applicant argues that the Ngo reference (USPN 6,818,557 B1) does not meet the subject matter of independent claims 1 and 5. The limitation "reacting said treated surface of said copper or copper alloy with trimethylsilane or terramethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions" is in both claims 1 and 5. The applicant argues that Ngo discloses the TMS flow regulating method before the PECVD silicon carbide deposition. The applicant also cites paragraph 21 of the currently filed specification to state that the pre-treatment process maybe performed by supplying trimethylsilane or terramethylsilane gas while simultaneously initiating the plasma. However paragraph 21 also states that *the trimethylsilane or terramethylsilane gas maybe supplied first and then the plasma is initiated.* In both cases the treated surface of the copper or copper alloy is reacted with trimethylsilane or terramethylsilane gas under PECVD conditions. In the Ngo reference, the TMS *is reacted* with the copper or copper alloy under PECVD conditions (column 6, lines 11-19). Therefore the rejection made in the previous Office action stands.
2. The objection made to the title in the previous Office action is hereby withdrawn in light of the newly amended title.

3. The objection made to claims 1 and 5 in the previous Office action is hereby withdrawn in light of newly amended claims 1 and 5.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1, 2, and 3 are rejected under 35 U.S.C. 102(e) as being anticipated by Ngo et al. (USPN 6,818,557 B1).

6. In reference to claim 1, Ngo et al. (USPN 6,818,557 B1, hereinafter referred to as the "Ngo" reference discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19).

7. With regard to claim 2, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

8. In reference to claim 3, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1).

11. With regard to claim 4, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 4 does not distinguish over the prior art reference of Ngo.

12. Claims 5, 6, 7, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1) in view of Xia et al. (United States Patent Application Publication No. US 2003/0068881 A1).

13. In reference to claim 5, Ngo (USPN 6,818,557 B1) discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19). Ngo does not disclose treating the silicon carbide capping layer with an ammonia plasma in order to remove oxygen from it. However such a plasma treatment is well known in the art. Xia et al. (United States Patent Application Publication No. US 2003/0068881 A1, hereinafter referred to as the "Xia" reference) discloses a silicon carbide layer which is treated with an in-situ ammonia plasma in order to remove contaminants from its surface (p. 4, paragraph 50). Ngo discloses that a silicon carbide layer free of contaminants is desirable in the art since it leads to a more reliable interconnect

structure (column 8, lines 30-36). In view of Xia, it would therefore be obvious to treat the silicon carbide layer of Ngo with an ammonia plasma.

14. With regard to claim 6, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

15. In reference to claim 7, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

16. With regard to claim 8, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 8 does not distinguish over the prior art references of Ngo and Xia.

17. Claims 5, 6, 7, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (USPN 6,818,557 B1) in view of Yang et al. (USPN 6365,527 B1).

18. In reference to claim 5, Ngo (USPN 6,818,557 B1) discloses a similar fabrication process. Figures 1-4 of Ngo illustrate a copper damascene process where a dielectric layer (10) is formed over a substrate (not shown). A damascene opening is etched into

the dielectric layer (10). The damascene opening is filled with copper (13A) or copper alloy (column 4, lines 59-65). The surface of the copper or copper alloy (13A) is treated with a hydrogen containing plasma (column 5, lines 49-62). The treated surface of the copper or copper alloy (13A) is reacted with trimethylsilane under plasma enhanced chemical vapor deposition (PECVD) conditions (column 6, lines 2-19). A silicon carbide capping layer (40) is in-situ deposited by PECVD (column 6, lines 2-19). Ngo does not disclose treating the silicon carbide capping layer with an ammonia plasma in order to remove oxygen from it. However such a plasma treatment is well known in the art. Yang et al. (USPN 6365,527 B1, hereinafter referred to as the "Yang" reference) discloses a silicon carbide layer which is treated with an in-situ ammonia plasma in order to remove oxygen from the layer (column 2, lines 15-21). Yang further discloses that a silicon carbide layer free of oxygen is desirable in the art (column 1, lines 59-61) since it leads to a better copper barrier (column 3, lines 41-45). In view of Yang, it would therefore be obvious to treat the silicon carbide layer of Ngo with an ammonia plasma.

19. With regard to claim 6, figure 1 shows that the damascene opening is lined with a diffusion barrier layer (12). Ngo discloses forming a seed layer on the diffusion barrier layer (12) and forming a copper or copper alloy (13a) on the seed layer (column 6, lines 58-60).

20. In reference to claim 7, Ngo makes it clear that the damascene opening may comprise a contact or via hole in communication with a trench opening (column 7, lines 58-61).

21. With regard to claim 8, Ngo discloses that the treated surface of the copper or copper alloy (13A) takes place at a process temperature of 335°C at a possible reaction duration of 30 seconds (column 6, lines 2-19). The copper or copper alloys (13a) is reacted with trimethylsilane with a gas flow in the range of 32 to 160 sccm (column 2, lines 2-19) which overlaps the range, "100 to 5000 sccm" as claimed by the applicant.

The examiner would like to note:

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP 2144.05.

Thus claim 8 does not distinguish over the prior art references of Ngo and Yang.

Conclusion

22. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Quinto whose telephone number is (571) 272-1920. The examiner can normally be reached on M-F 8AM-5PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

KVQ

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